# BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

## IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.**

(19) JAPANESE PATENT OFFICE (JP)

(12) PUBLICATION OF UNEXAMINED PATENT APPLICATION (A)

(11) Patent Application Disclosure (Kokai) Number: Hei 5-78945

(43) Date of Disclosure: March 30, 1993

| (51) Int. Cl.[5] | | Identif. Symbol | Intra-Office File Number | FI | Technology Indication |
|---|---|---|---|---|---|
| D 03 D | 1/00 | Z | 7199-3B | | |
| | 15/12 | A | 7199-3B | | |

Number of Claims: 2 (Total of 5 pages)
Request for Examination: not yet requested

(21) Application Number: Hei 3-87232

(22) Filing Date: March 28, 1991

(71) Applicant: 000003975
Nitto Boseki Co., Ltd.
Fukujima-ken, Fukujima-shi,
Satonome Aza, Higashi, 1-banchi

(72) Inventor: Keita Miyazato
Fukujima-ken, Fukujima-shi
Toyano Aza, Hino 2-7

(54) Name of the Invention: GLASS FIBER WOVEN FABRIC FOR PRINTED CIRCUIT BOARDS

(57) (Summary)

(Purpose)

The purpose of this invention is to obtain a glass fiber woven fabric for printed circuit boards, enabling to produce prepreg which has few pinholes or voids, and which has an excellent resin impregnating ability.

(Construction)

The glass fiber woven fabric uses a glass woven fabric with a total of 40 driving counts per 25 mm of vertical yarn (warp) and horizontal yarn (weft), and a glass fiber with a unit weight

of at least 180 g/m$^2$ characterized by air permeability of no more than 50 cm$^3$ / cm$^2$ /sec, or with a total of 60 driving counts per 25 mm of vertical yarn and horizontal yarn, using a unit weight at least 100 g/m$^2$ and no more than 180 g/m$^2$, and with air permeability of no more than 80 cm$^3$/cm$^2$/sec.

[see figure]

(Scope of the Patent's Claim)

(Claim 1)

A glass fiber woven fabric, characterized by the fact that a glass woven fabric has a total of 40 driving counts per 25 mm of vertical yarn (warp) and horizontal yarn (weft), using a glass fiber with a unit weight of at least 180 g/m$^2$ and with air permeability of no more than 50 cm$^3$/cm$^2$ /sec.

(Claim 2)

A glass fiber woven fabric, characterized by the fact that a glass woven fabric has a total of 60 driving counts per 25 mm of vertical yarn and horizontal yarn, using a unit weight at least 100 g/m$^2$ and no more than 180 g/m$^2$, and with air permeability of no more than 80 cm$^3$/cm$^2$/sec.

(Detailed Explanation of the Invention)

(0001)

(Sphere of Industrial Use)

This invention relates to a glass fiber woven fabric which can be used for printed circuit boards, in particular a glass fiber woven fabric which can be manufactured at a low cost and which enables to obtain prepreg having few pin holes.

(0002)

(Prior Art Technology)

Different types of printed circuit boards are manufactured depending on the type of the construction elements which are used in these boards. A glass fiber woven fabric is used as base material in these boards because this material has excellent electric characteristics as well as excellent mechanical characteristics, a superior heat resistance and other advantages, which is why it is often used in different types of electrical devices. Although there are different types of glass fiber woven fabrics, not that many types of glass fiber woven fabrics are being used at present in printed circuit boards. Particularly large amounts are used at present in printed circuit

boards in case of the universal type of boards belonging to type 7628 which is determined by MIL standards (MIL spec. Y-1140H), and in case of boards of type 2116, belonging to the same type of multi-layered boards. Table 1 indicates the specifications for this type of woven fabric.

(0003)

(Table 1)

| | Textile Yarn Number Count of Used Yarn | Driving Count (Fibers/25 mm) | Weight ($g/m^2$) |
|---|---|---|---|
| type 2116 | 22.5 x 22.5 | 59 x 56 | 106 |
| type 7628 | 67.5 x 67.5 | 43 x 33 | 208 |

(0004)

The requirement to bring the cost down, which is strongly emphasized in the printed board manufacturing industry, has lead to an examination of different types of measures aimed at cost reductions. From the viewpoint of the raw materials, for example, it is possible either to add a filling agent to a matrix resin, or it is also possible to use a glass fiber paper instead of a glass fiber woven fabric, etc., for this purpose. One of the measures aimed at bringing the cost down is a procedure according to which a thicker woven fabric is used in the glass fiber woven fabric. Generally, the universal type of printed circuit boards uses laminated layers of copper foils and 8 prepreg sheets with the 7628 type of glass fiber woven fabric. This is then processed in a heat press in order to obtain a printed circuit board with a thickness of 1.6 mm. If in this case, a glass fiber woven fabric which has a higher count of glass fibers is used instead of the glass fiber woven fabric of type 7628, this makes it possible to reduce the number of sheets used in the laminated layers of the prepreg from 8 sheets to 6 sheets or to 5 sheets. Because a thicker woven fabric is normally preferable when used for a glass fiber woven fabric, the cost of the raw materials used in the whole structure of the woven product plays a role in the cost of the product regardless of the relative importance of the weight of the fiber and of the unit cost per $m^2$. Accordingly, when a thicker glass fiber woven fabric is used, this brings down the cost of the raw materials in the woven fabric and when the number of the prepreg plies is reduced, the resulting effect is a lower cost of the laminated layers, which makes it possible to reduce the cost of a printed circuit board.

(0005)

On the other hand, although it is possible to create a cheaper design of a printed circuit board by using a thicker glass fiber woven fiber, there are problems connected with the capacity of a printed circuit board which is obtained in this manner. For example, the impregnating capability of the resin on the fiber will be poor when a larger count of grass fibers is used. This impregnating capability of the resin will be particularly poor in the part in which vertical yarn intersects the horizontal yarn. In addition, when a higher (thicker) count of the yarn is used, the

weave texture of the woven fabric will be particularly conspicuous on the surface of the printed circuit board, which in itself is a problem because this results in a poor smoothness of the surface. Accordingly, although using a thicker glass fiber woven product is an effective method enabling to bring the cost down, the present situation is that this method has not been put to practical use due to problems related to the performance aspects. The same principle is applicable also to type 2116 which is used with multilayered boards. And since the requirement on performance aspects are even more stringent in case of multilayered boards, this makes the application of a similar method that much more difficult.

(0006)

(Task To Be Solved By This Invention)

The task which is to be solved by this invention is to obtain a glass fiber woven fabric for printed circuit boards which is not only cheaper than the glass fiber woven fabric product that is generally used for many types of products, such as the type 7628 or the type 2116, but which also displays a better performance in a printed circuit board obtained in this manner, so that the printed circuit board using this glass fiber woven fabric provides the same or better capability of the printed circuit board than the performance of printed circuit boards of the type 7628 or the type 2116.

(0007)

(Means To Achieve The Task)

In order to achieve the above mentioned task, this invention provides a glass fiber woven fabric for use in printed circuit boards which can be used instead of the glass fiber woven fabric type 7628, having a total of no more than 40 driving counts per 25 mm of vertical yarn and horizontal yarn, with a unit weight of no more than 180 $g/m^2$, and with an air permeability of no more than 50 $cm^3/cm^2/sec$. In addition, this invention provides a glass fiber woven fabric for use in printed circuit boards which can be used instead of the glass fiber woven fabric type 2116, having a total of no more than 60 driving counts per 25 mm of vertical yarn and horizontal yarn, with a unit weight of at least 100 $g/m^2$ and no more than 180 $g/m^2$, and with an air permeability of no more than 80 $cm^3/cm^2/sec$.

(0008)

When the glass fiber woven product of this invention is replacing the 7628 type of glass fiber woven product, it is possible to use for example a yarn which has double the count of the yarn number count of the fiber use for type 7628, with a total of nor more than 40 driving counts per 25 mm of vertical yarn and horizontal yarn. In addition, since the yarn is thicker when the unit weight is set to 200 g, which is approximately the same as the unit weight of type 7628, in addition to the problem which is known as poor resign impregnating capability, another problem is that since the total count is less than 40 driving counts for vertical and horizontal yarn, vertical

yarn 1 of the woven fiber is surrounded by horizontal yarn 2, creating a large surface area of eyelet part 3 as shown in Figure 1. Accordingly, this means that pinholes or voids, etc., can easily occur in eyelet part 3. The result is that when a similar type of prepreg is used in order to manufacture a circuit board, pin holes or voids can easily be created in the printed circuit board even if care is taken to prevent this.

(0009)

In order to solve this problem in accordance with the glass fiber woven fabric of this invention, weave opening processing is conducted after weaving to create a flattened design of the open weave with the vertical yarn in the structure of the woven fiber. This makes it possible to create a very small surface area of the eyelet part 3' which is surround by vertical yarn 1' and horizontal yarn 2' of the woven fiber as shown in Figure 2. As a result of that, the air permeability of the glass fiber woven fabric of this product is less than 50 $cm^3/cm^2/sec$, which corresponds to products of type 7628, or less than 80 $cm^3/cm^2/sec$, which corresponds to products of type 2116. Although different types of methods can be used for the weave opening processing of the woven fabric, the use of a high-pressure current processing device which was disclosed in Japanese Patent Application Number Sho 61-230900 is optimal for this purpose. When this device is used, pressurized water is sprayed with a pressure in the range of 30 $kg/cm^2$ ~ 150 $cm^2$, which makes it possible to conduct a homogenous weave opening processing along the entire surface of the woven fiber. Although this weave opening processing can be conducted immediately after weaving, it is preferable when it is conducted continuously with the surface treatment process.

(0010)

(Operation)

Because the glass fiber woven fabric of this invention can be used with a thicker yarn number count than the yarn of type 7628 or of type 2116 which are commonly used at present, this makes it possible to reduce the driving count horizontal yarn by 40% ~ 50%. Accordingly, the weaving efficiency is improved which makes it possible to bring the cost down. In addition, since the driving count of the vertical yarn can be also reduced to the same extent, the result is that the production efficiency of the warping beam of the vertical yarn can be improved, which also helps to bring the cost down.

Moreover, because weave opening processing is also applied to the glass fiber woven yarn of this invention, a flattened structure of an open weave construction comprising the warp and the weft is created by this. Accordingly, the surface area of they eyelet part is extremely small even though the driving count is smaller, and also the air permeability is set to a low constant level. Because of that, the glass fiber woven fabric of this invention has an excellent impregnating capability with a sufficiently open weave comprising the warp and the weft, while an optimal impregnation with a resin is enabled thanks to the flattened design of the fabric,

enabling easy impregnation with the resin also in the yarn intersecting part.

(0011)

Because the surface area of the eyelet is very small, this means that pinholes or voids, etc., are unlikely to be generated in this part. Therefore, when the glass fiber woven fabric of this invention is used with its thicker yarn number count, this provides for an optimal smoothness of the surface of the substrate when the fabric is used for a prepreg of a circuit wiring board thanks to its flattened design and thanks to the open weave of the yarn.

(0012)

(Embodiments)

(Embodiment 1)

A glass fiber woven fabric having a yarn number count of 135 tex (ECG 37 1/0) was used for the vertical yarn (warp) and for the horizontal yarn (weft) to obtain a glass fiber woven fabric woven with 21 yarns/25 mm for the driving count of the vertical yarn and 17 yarns/25 mm for the driving count of the horizontal yarn (unit weight = 206 $g/m^2$). After heating and deoiling was applied to this woven fabric according to a customary method, γ-glycidoxy propyl triemthoxy silane was used as a silane coupling agent for surface treatment. The deposit rate of the surface treatment agent was 0.1%. The glass fiber woven fabric which was subjected to surface treatment was also subjected to weave opening treatment with a high-pressure current processing device which was disclosed in Japanese Patent Application Number 61-230900. A high water pressure of 100 $kg/cm^2$ was used for this purpose. The glass fiber woven fabric which was treated by weave opening treatment was impregnated with an epoxy resin varnish having the G-10 composition and when prepreg was formed, measurements were conducted to indicate the presence or absence of pin holes and to measure the impregnating characteristics. The results are shown in Table 3. In addition, although the air permeability of this glass fiber woven fiber was 84.5 $cm^3/cm^2/sec$ before the weave opening treatment was conducted, its air permeability after the weave opening treatment was 36.1 $cm^3/cm^2/sec$.

(0013)

Embodiment 2

A glass fiber woven fabric having a yarn number count of 44.5 tex (ECE 1101/0) was used for the vertical yarn (warp) and for the horizontal yarn (weft) to obtain a glass fiber woven fabric woven with 29 yarns/25 mm for the driving count of the vertical yarn and 28 yarns/25 mm for the driving count of the horizontal yarn (unit weight = 106 $g/m^2$). After heating and deoiling was applied to this woven fabric according to a customary method, γ-glycidoxy propyl triemthoxy silane was used as a silane coupling agent for surface treatment. The deposit rate of the surface treatment agent was 0.1%. The glass fiber woven fabric which was subjected to

surface treatment was also subjected to weave opening treatment with a high-pressure current processing device which was disclosed in Japanese Patent Application Number 61-23090. A high water pressure of 70 $kg/cm^2$ was used for this purpose. The glass fiber woven fabric which was treated by weave opening treatment was impregnated with an epoxy resin varnish having the G-10 composition and when prepreg was formed, measurements were conducted to indicate the presence or absence of pin holes and to measure the impregnating characteristics. The results are shown in Table 3. Although the air permeability of this glass fiber woven fiber was 118.2 $cm^3/cm^2/sec$ before the weave opening treatment was conducted, its air permeability after the weave opening treatment was 63.6 $cm^3/cm^2/sec$.

(0014)

(Comparative Example 1)

A glass fiber woven fabric having a yarn number count of 67.5 tex (ECG 75 1/0) was used for the vertical yarn (warp) and for the horizontal yarn (weft) to obtain a glass fiber woven fabric woven with 43 yarns/25 mm for the driving count of the vertical yarn and 33 yarns/25 mm for the driving count of the horizontal yarn (unit weight of type 7628 = 208 $g/m^2$). After heating and deoiling was applied to this woven fabric according to a customary method, γ-glycidoxy propyl triemthoxy silane was used as a silane coupling agent for surface treatment. The deposit rate of the surface treatment agent was 0.1%. The glass fiber woven fabric which was subjected to surface treatment was impregnated with an epoxy resin varnish having the G-10 composition and when prepreg was formed, measurements were conducted to indicate the presence or absence of pin holes and to measure the impregnating characteristics. The results are shown in Table 3

(0015)

(Comparative Example 2)

A glass fiber woven fabric having a yarn number count of 22.5 tex (ECE 225 1/0) was used for the vertical yarn (warp) and for the horizontal yarn (weft) to obtain a glass fiber woven fabric woven with 59 yarns/25 mm for the driving count of the vertical yarn and with 56 yarns/25 mm for the driving count of the horizontal yarn (unit weight of type 2116 = 107 $g/m^2$). After heating and deoiling was applied to this woven fabric according to a customary method, γ-glycidoxy propyl triemthoxy silane was used as a silane coupling agent for surface treatment. The deposit rate of the surface treatment agent was 0.1%. The glass fiber woven fabric which was subjected to surface treatment was impregnated with an epoxy resin varnish having the G-10 composition and when prepreg was formed, measurements were conducted to indicate the presence or absence of pin holes and to measure the impregnating characteristics. The results are shown in Table 3.

(0016)

Table 2 shows the specifications of the glass fiber woven fabrics in the above described embodiments and comparative examples.

(0017)

Table 2

| | Used Yarn | Driving Count (Yarns/25 mm) | Unit Weight ($g/m^2$) |
|---|---|---|---|
| Warp<br>Embodiment 1<br>Weft | ECG 37 1/0<br><br>ECG 37 1/0 | 21<br><br>17 | 206 |
| Warp<br>Embodiment 2<br>Weft | ECE 110 1/0<br><br>ECE 110 1/0 | 29<br><br>28 | 106 |
| Warp<br>Compar. Example 1<br>Weft | ECG 75 1/0<br><br>ECG 75 1/0 | 43<br><br>33 | 208 |
| Warp<br>Compar. Example 2<br>Weft | ECE 225 1/0<br><br>ECE 225 1/0 | 59<br><br>56 | 107 |

Comparative Example 1 - glass fiber woven fabric ECE 110 1/0 7 µm x 400 filaments.
Respective filaments in Comparative Example 2 - ECE 225 1/0 7 µm x 200 filaments,
- ECG 37 1/0 9 µm x 800 filaments,
- ECG 75 1/0 9 µm x 400 filaments.

(0018)

(Table 3)

Table 3

| | Weaving Characteristics (hrs/100 mm) | Presence or Absence of Pin Holes | Impregnating Characteristics (No. of Items) | Air Permeability ($cm^3/cm^2/sec$) |
|---|---|---|---|---|
| Embodiment 1 | 2.2 | none | 3 | 36.1 |
| Embodiment 2 | 5.2 | none | 5 | 63.6 |
| Compar. Ex. 1 | 5.5 | none | 28 | 13.2 |
| Compar. Ex. 2 | 10.3 | none | 32 | 45.5 |

The weaving characteristics were measured as the time required to produce 100 m of woven product, the impregnating characteristics were measured as the number of voids in the prepreg per 5 cm square, the air permeability was the measured value measured during the glass fiber woven fiber status.

The testing method was used according to JIS [Japanese Industrial Standard] L 1096 "Air Permeability Test".

(0019)

(Effect of the Invention)

Because the glass fiber woven fabric of this invention has the characteristics which are indicated in Table 3, its weaving characteristics are about twice as good as those of products belonging to type 7628 and type 2116 which were produced according to conventional methods. Since this enables a proportional reduction of the cost, and since the yarn which has been treated by weave opening treatment has a low air permeability which is below a constant value regardless of the fact that a thick yarn number count is used, this makes it possible to obtain prepreg which has fewer pin holes or voids than woven fabrics manufactured according to prior art.

The result of this is that this design makes it possible to provide an expensive printed circuit board which can offer the same or better performance than conventional products.

(Brief Explanation of Figures)

(Figure 1)

An enlarged view showing the surface of one embodiment of the glass fiber woven fiber of this invention before the weave opening treatment.

(Figure 2)

An enlarged view showing the surface of one embodiment of the glass fiber woven fiber of this invention.

(Explanation of Codes)

1 vertical yarn,
1' vertical yarn,
2 horizontal yarn,
2' horizontal yarn,
3 eyelet part,

3' eyelet part.

[Figure 1]

[Figure 2]